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DATA AVAILABILITY, DATA QUALITY IN LCA

Comparison of two versions of an EPD, using generic and specific data for the foreground system, and some methodological implications

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Abstract
Purpose Differences in the practice of inclusion and the definition of specific and generic data when performing an LCA for an Environmental Product Declaration (EPD) may lead to incomparable EPDs. The purpose of this paper is to illuminate the importance of precise definitions regarding data quality in EPDs.
Method The authors define relevant terminology before describing methodological differences between two versions of EPDs for an office chair. The analyses performed for one EPD use *generic* data for the foreground system, while the other uses *specific* data. Results for some impact categories as well as inventory findings are shown, and the reasons for differences are investigated and discussed.
Results Relevant dilemmas are examined with regard to the choice of generic or specific data. These include practical hindrances and the promotion of environmental improvement. Some preliminary methodological and organisational implications are described, followed by an outline of further research.
Conclusions This paper shows the substantial variations arising from using two datasets with different degrees of specificity, and concludes that they increase in relation to the distinctiveness of the process or material. This highlights the importance of EPD programmes in establishing precise, unambiguous definitions and vocabulary with regard to specific as against generic data, when combined with foreground and background processes. It is essential to take this into consideration so as to avoid misunderstandings or false agreement when discussing data quality. It is also necessary in order to avoid comparisons of products based on very different assumptions.

Keywords Data quality · Environmental product declarations · Foreground processes · Generic data · Specific data

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1 Introduction

Programmes for Environmental Product Declarations (EPDs), Type III, based on life cycle assessment (LCA) studies are now in place in several countries, resulting in declarations originating from Sweden, Italy, Japan, Canada, Germany, France and Norway among others (Baumann and Tillman 2004; Institut Bauen und Umwelt 2012; INIES 2012; BRE 2012). Ostfold Research has been actively involved in developing the EPD system in Norway as well as producing EPDs for several types of products from Norwegian companies. The process of data gathering for the LCA studies that form the basis for the EPDs can be prohibitively expensive and time-consuming (Reap et al. 2008b), and some actors in the EPD field (for example Fet et al. 2006a) have suggested that database data are adequate for the purpose of EPDs, rather than using company-specific data. Zackrisson et al. (2008) identify the amount of work required to do a full EPD based on an LCA as a major obstacle for SMEs. Hunkeler and Reibitzer (2005) identified important issues for the future of LCA. These included the need for evaluations and comparisons of the results obtained through different variants of the methodology, issues related

to uncertainty and data quality, as well as life cycle impact assessment sophistication. This paper addresses some of the issues arising from the increasing use of databases and software systems in the application of simplified LCA to produce EPDs. Results are presented here from an LCA case study on an office chair made by the Norwegian company HÅG. The case study was performed twice, once using specific data for the foreground system and once using general data. This was in order to illustrate the potential magnitude of variation in results when the two approaches are applied. The seating solution by HÅG is made of a range of materials with varying recycled content, and the results identify specific data and give an indication of how important these can be for certain types of materials.

1.1 Definitions, clarifications and limitations

The distinction between specific and generic data is not clearly defined within the field of LCA. Sometimes the notion of “specific data” includes, and is partitioned into, “company specific data” and “specific database data”, where the latter must fulfil certain requirements in order to be classified as “specific”. However, for the purpose of this article, specific data is hereafter used only to denote data that represent activities in the companies in question. All other types of data are defined as generic. Thus, in the case study presented, data from the database EcoInvent 2.2 is defined as generic data.

The terms “Specific EPD” and “Generic EPD” used in this paper are defined as EPDs based on specific and generic data for the foreground system, respectively. According to Baumann and Tillman (2004), “foreground processes” are activities and processes which take place at the EPD commissioner and its suppliers (one step upstream in the value chain). “Background processes” are activities and processes further upstream (at the suppliers to the suppliers and all the way back to the extraction of the raw material) or downstream. The International Reference Life Cycle Data System (ILCD) handbook (European Commission 2010) defines the foreground system as “those processes of the system that are specific to it”. The background system is that part of the system where, because of an averaging effect at supplier level, a homogenous market with average or generic data can be assumed properly to represent the respective process.

For the purposes of this paper, it was considered both appropriate and expeditious to include only the cradle to gate stages of the life cycle, thus concentrating on one topic only. Research questions regarding scenarios for use and end of life stages in the product life cycle deserve their own papers. Recycling allocation principles will not be discussed, but the same principle is applied consistently in the LCAs, namely the cutoff method (Baumann and Tillman 2004).

1.2 The purpose of Environmental Product Declarations and the underlying LCAs

The primary aim of EPDs is to communicate the environmental performance of goods and services in order to enable comparisons between products, first and foremost to be used in business-to-business procurement. This is stated clearly in both the EPD standard (ISO 2006a) and on the web pages of some of the programme operators. However, the necessary underlying LCA is also promoted as a starting point for improvements in products or services (Baumann and Tillman 2004; Barbarenda Gamage et al. 2008). Using the EPD process as a basis for improvements has been the case in Norwegian industry. In the case of the office chair producer HÅG, their first EPDs led to a supplier improvement project as well as internal product design decisions which took the environment into account (Modahl and Nereng 2007). The Norwegian trade association (NHO) also promotes EPDs for product development and improvement as well as documentation (Fet et al. 2006b).

1.3 Data quality requirements in the standards and Product Category Rules

The experienced LCA practitioner will already be acquainted with LCA and EPD data quality requirements, but the authors have here provided a brief summary. The broad LCA standard (ISO 2006b) states that data quality requirements depend on the goal and scope of the study, while the EPD standard ISO 14025 (2006a) only describes which quality requirements should be included in the various Product Category Rules (PCR). These are as follows: “coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty,....” ISO 14025 (2006a) states that both data description and data quality requirements should be “equivalent”, as opposed to “identical”, for EPDs that are to be compared. However, the standard does not define equivalence. The CEN 15941 technical report for selection and use of generic data for EPD within the construction sector (PD CEN/TR 15941 2010) states that “specific data for a certain product or process should be used” and that “generic data should never replace specific data when specific data are available”. The ILCD Handbook (European Commission 2010) has been developed as a supplement to the standards for LCA practitioners. This is in order to give more specific guidelines dependent on the goal and scope of the study. This handbook describes data quality with regard to the degree to which it is representative, complete, precise or uncertain, and methodologically appropriate and consistent. Emerging standards and guidelines recommend that specific data be used for foreground systems (e.g. draft documents, currently not officially published, available from the European Committee for

Standardization, CEN, and European Commission JRC Sustainability Assessment unit).

PCRs are sets of rules, requirements and guidelines for developing Type III environmental declarations for product categories. Thus, a specific PCR can be applied to groups of products that can fulfil equivalent functions (ISO 2006a). PCRs are therefore important in the comparison and inclusion of relevant life cycle phases and environmental impacts. A PCR is therefore a more concrete guideline building on the EPD standard. When consulting the relevant PCR for seating solutions (Fet and Skaar 2008) for the case studied in this paper, one finds that for the “supplement of data, specific data should be prioritized. In the absence of other specific data, data from databases can be used” (ibid p. 5) if they follow rules with regard to geographical area, technology, boundaries with nature and allocation. PCRs for different products may have different data requirements.

2 Methods

2.1 The case: seating solution EPD

The two approaches to foreground data are compared by performing the same cradle to gate analyses required for EPDs for an office chair using the two different types of foreground data under discussion. The system boundaries and scope of the analyses are the same, but the specific foreground data used in the original EPD work for HÅG have been replaced by generic data in the second analysis. For recycled content, the cutoff allocation principle is applied. Thus, the virgin material production is allocated to the first product and the recycling process to the second (Baumann and Tillman 2004). As mentioned above, the Norwegian PCR (Fet and Skaar 2008) which was followed was that for seating solutions. The chair in question is one of the Norwegian company HÅG's most widely sold chairs, the office chair H05 5300. It is one of the 11 chairs that HÅG currently has EPDs for, published via the Norwegian EPD programme. Data from the last declaration update are used in the specific EPD case, namely data representing the year 2006 (Nereng and Modahl 2007).

The declared unit of the LCA study is one seating solution at the point of manufacture. In an approved EPD, the declared unit would have been one seating solution, manufactured and maintained for 15 years, according to the PCR (Fet and Skaar 2008). This adjustment is a simplification and will not affect the conclusions of the analysis. Table 1 describes the main material composition of the case seating solution, according to weight.

2.2 Data quality

Table 2 shows the various items constituting the foreground data that are compared in the study. For the case of comparison, the generic EPD was composed with as little company information as possible, thus representing a case where no information other than the material types and masses is given from the commissioning company. It could be argued that in a realistic data gathering process, some information could be found within data which is readily available from the commissioner. This might be recycled content and type of production process, for example a foot base made from 60 % recycled and moulded aluminium. For the first iteration of this research, only the two extremes are compared. In order to gain more information and create a more thorough discussion of the results, a third comparison was performed on two of the materials, using generic data with the specific recycled content.

Table 1 Material composition and foreground data characteristics for these materials in the two LCAs of HÅG’s office chair H05 5300

Material	Percentage of product (%)	Recycled content	
		Specific EPD	Generic EPD
Steel	39	From 0 to 100 %; average[a] for HAAG’s suppliers, 48 %	37.00 %
Aluminium	20	From 0 to 100 %; average[a] for HAAG’s suppliers, 76 %	10 % new scrap, 32 % including new and old scrap
Other metal	0.5	0 %	0 %
PUR	5.5	0 %	0 %
Plastics	16	0 and 100 % (one component); average[a] for HAAG’s suppliers, 45 %	0 %
Textile	1.3	0 %	0 %
Other material	6.4	40 %	0 %
Packaging/ cardboard	10.4	43 %	50 %

Specific numbers are used for recycled content for each supplier in the specific EPD

[a]Additional information

Table 2 Foreground data characteristics for the two LCAs of HÅG's office chair H05 5300

Data type	Specific EPD	Generic EPD
Material amounts in product	Specific data	Specific data
Recycled content of material	Specific data	Generic data: EcoInvent 2.2
Component production processes	Specific data	Assumption based, Generic data: EcoInvent 2.2
Processes at EPD commissioner/chair assembly process+metalworking	Specific data:	Specific data:
	Welding	Amount of welding
	Metalworking	Amount of metal work
	Mounting of chairs	Energy consumption
	Office functions	Generic data: EcoInvent 2.2
		Welding process
		Metal work process
		Energy mix
Energy mixes at suppliers'	Specific data	Generic data: EcoInvent 2.2
Transport distances (from supplier's supplier and supplier to chair company)	Specific data	Assumption based
Vehicle types for the transport	Specific data	Assumption based

The data characterised in Table 2 include: consumption of materials and additives; consumption of energy carriers; emissions to air, water and soil from production and consumption of energy/fuels like diesel, and amounts of waste and waste treatment. Table 2 shows that the data for the background system are generic in both cases. The background system includes the extraction of raw material and subsequent processing into base material; energy carrier production and transmission, and transport.

The background system fulfils the representativeness requirements. As materials are generally bought on the European or international market, the generic data would be at the correct resolution level, and could thus earn the title "specific database data" as mentioned earlier. This also depicts a realistic and pragmatic picture as this type of information so far upstream in the value chain is both dispersed and almost to impossible to collect.

Table 1 presents the material content of the product, including the recycled content of the materials used, as divided into generic and specific data. Generally, the recycled content of the materials with specific data varies according to the type of material in question, while the recycled content for the materials entered in the generic EPD remains the same as for the European average. As HÅG has negotiated specific purchasing agreements with the suppliers of their materials, the recycled content for the materials with specific data is typically higher than the European average.

2.3 Life Cycle Inventory and impact analysis

SimaPro software (Pré Consultants 2011) was used here to carry out both of the LCAs. The impact analysis was done according to the CML 2 baseline 2000 method (CML 2010), with the exception of Global Warming Potential (GWP). This was updated to be in line with the most current characterisation factors presented by the Intergovernmental Panel on Climate Change (Metz et al. 2007). The conventional 100-year perspective on GWP was applied. In order to limit the scope of the paper and the case presented, not all inventory results are shown, but the environmental impacts requested by the PCR (Fet and Skaar 2008) are presented in the following section.

3 LCA results

The environmental impacts, along with some inventory results, are shown for the chair as a whole in Fig. 1, presenting the findings as percentages relative to the specific EPD. For all indicators, the generic EPD shows a higher impact than the specific, and five of the indicators show results that are much greater than those for the specific case. The waste generation indicator has the smallest difference in that the "generic chair" produces 133 % of the waste occurring in the production and assembly stages of the specific case.

In order to further investigate the differences between the generic and the specific EPDs, the Life Cycle Inventory (LCI) and impact category results from Fig. 1 are shown in more detail in Figs. 2, 3, 4, 5, 6 and 7. The figures show the contributions for each of the materials and the processes "Transport to HÅG" and "HÅG processes".

Figs. 2, 3, 4, 5, 6 and 7 all show similar trends. The largest differences between the two EPDs can be seen in Fig. 6, eutrophication, and the smallest in Fig. 7, waste generation. This corresponds with the results shown in Fig. 1. Aluminium, steel and textiles are the materials which

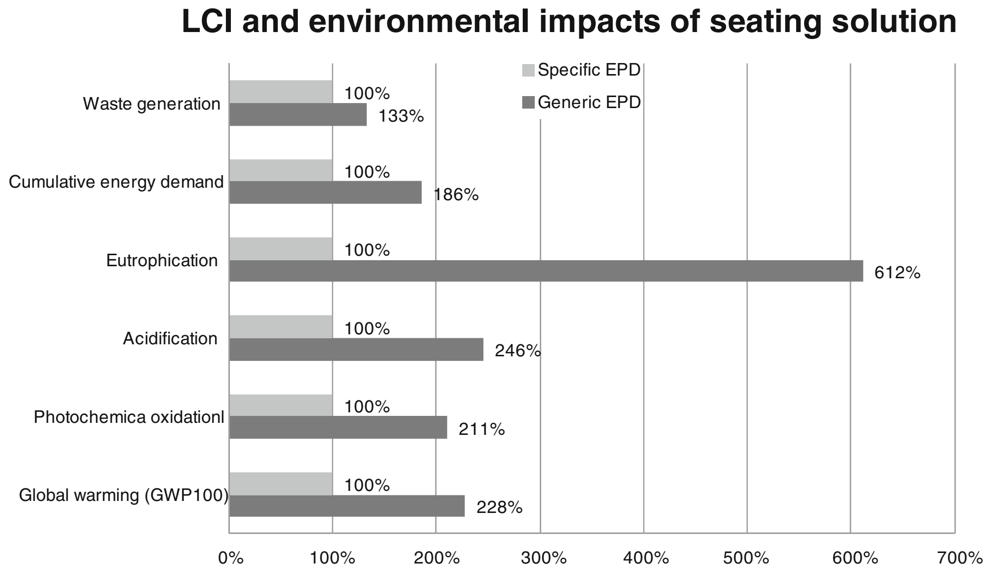

Fig. 1 Environmental impacts from the generic EPD relative to the specific EPD (100 %)

show the greatest differences between the specific and generic EPDs. The "HÅG process" also shows a large difference for most impacts. For plastics, the difference between generic and specific data is smaller. However, the results for the generic EPD show a larger impact for plastics than the specific in all the categories apart from photochemical oxidation (Fig. 4). The only other process or material where the specific EPD has a higher potential impact than the generic EPD is the "HÅG process" in Fig. 7, waste generation.

In addition, it should be noted that the differences are not equal and relative to each other in all of the LCI results and environmental impacts. For GWP, cumulative energy demand (CED), photochemical oxidation and acidification (see Figs. 2, 3, 4 and 5), aluminium and steel are the materials with the highest impact in the generic EPD. In the specific EPD, however, the plastic materials have an impact close to that of aluminium, while steel is the material with the third highest impact.

4 Discussion

4.1 Exploring the results

HÅG has a rigorous environmental policy (Scandinavian Business Seating 2011). This requires them to produce "more with less" through a combination of good quality, long service life, rational production and good design with low weight, few components and renewable or recyclable materials. This environmental awareness means that the results obtained for HÅG's specific case are lower than they would be for the average/general case. It is likely that a company that does not have this focus would not achieve the same (low) results. Thus, the authors expected that HÅG's EPDs would be a good illustrative case on which to base a specific/generic EPD comparison.

Some of the differences in some of the material groups can be explained by the variation in recycled content. It is

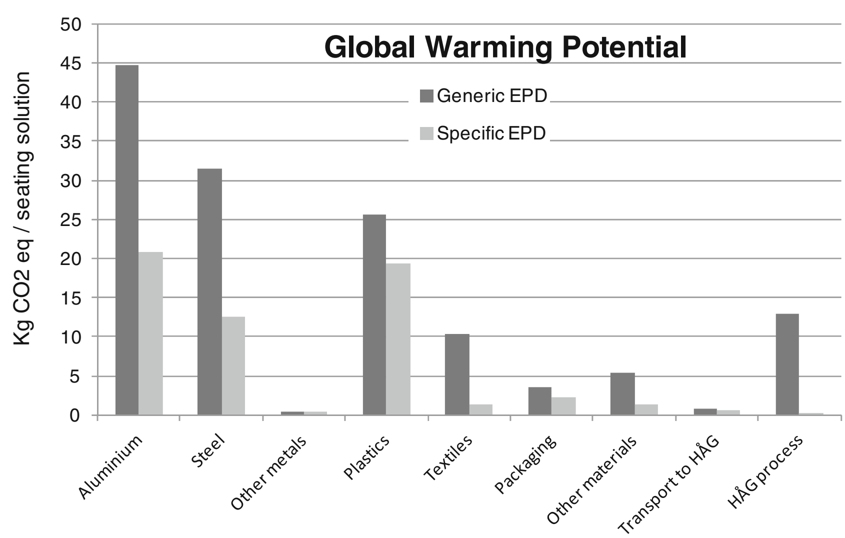

Fig. 2 Comparison of absolute values for GWP impact sorted according to materials, transport to HÅG and HÅG process for one seating solution

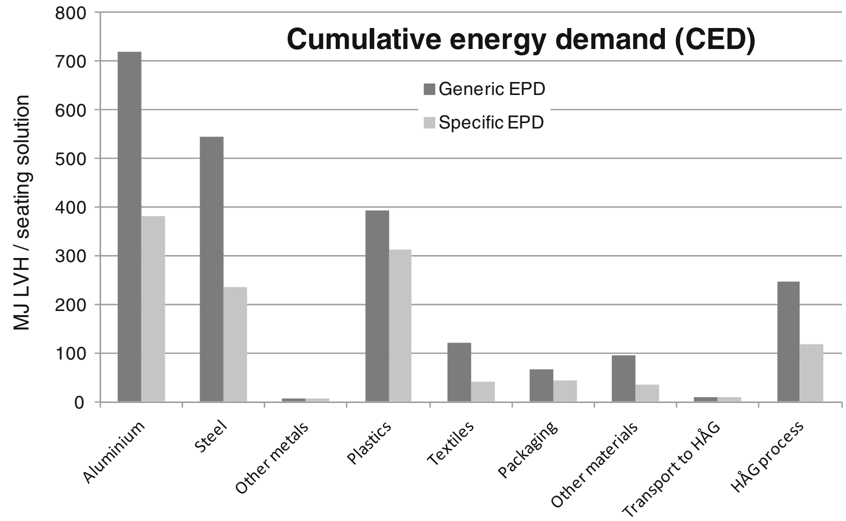

Fig. 3 Comparison of absolute values for energy consumption sorted according to materials, transport to HÅG and HÅG process for one seating solution

known from other studies and from EPDs that raw material extraction normally contributes a significant proportion of the environmental impacts in the value chain of manufactured products (Babarenda Gamage et al. 2008; Baumann and Tillman 2004). This, combined with the fact that raw material extraction is omitted from the inventory for recycled materials, makes it reasonable to conclude that the variation between the two types of EPDs is due to the variation in the recycled content of steel and aluminium. Table 1 shows the material composition of the office chair in combination with each material's range of modelled recycled content. It becomes clear that this is a probable cause of the differences described since some of the steel and aluminium used in the specific EPD has up to 100 % recycled content, and the average recycled content is higher than for the generic data. The CED graphs for steel and aluminium show the same pattern. As metal production and particularly production of aluminium is highly energy intensive, the recycled content of metals becomes an essential parameter for inclusion in an LCA and EPD. For plastics, the difference in recycled content does not play a significant role because production of the base materials is less energy intensive. As a result of this, the authors contend that *recycled content must be included, regardless of material, in LCAs used as the basis for EPDs.*

To test the above hypothesis, a third comparison was performed, where the generic aluminium data were amended to include the specific recycled content. A similar change was made to the plastic material polypropylene (PP), before both were compared to the generic and specific data for each material, for the environmental impact GWP. This is presented in Figs. 8 and 9, respectively.

These results support the above analysis and show that for aluminium, the recycled content is important. Inclusion of the correct recycled content means that the GWP based on the generic data with the specific recycled content is only

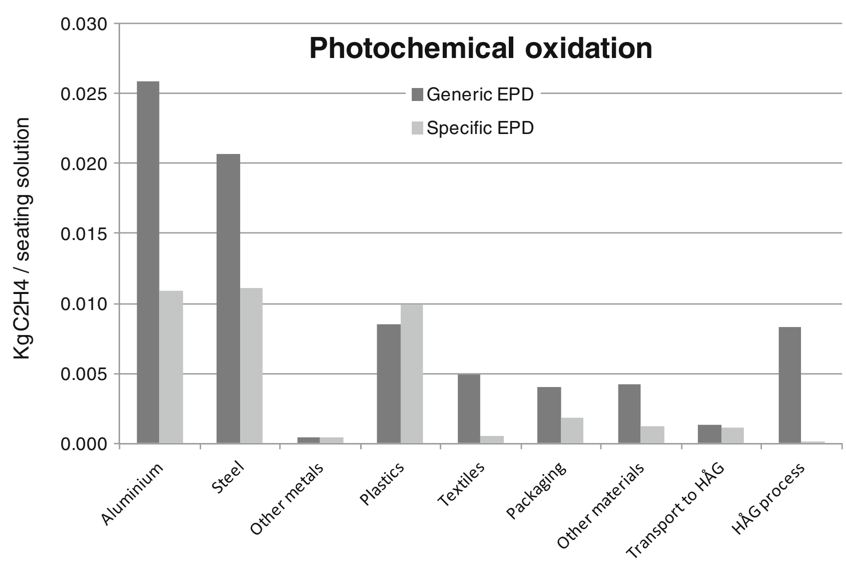

Fig. 4 Comparison of absolute values for photochemical oxidation impact sorted according to materials, transport to HÅG and HÅG process for one seating solution

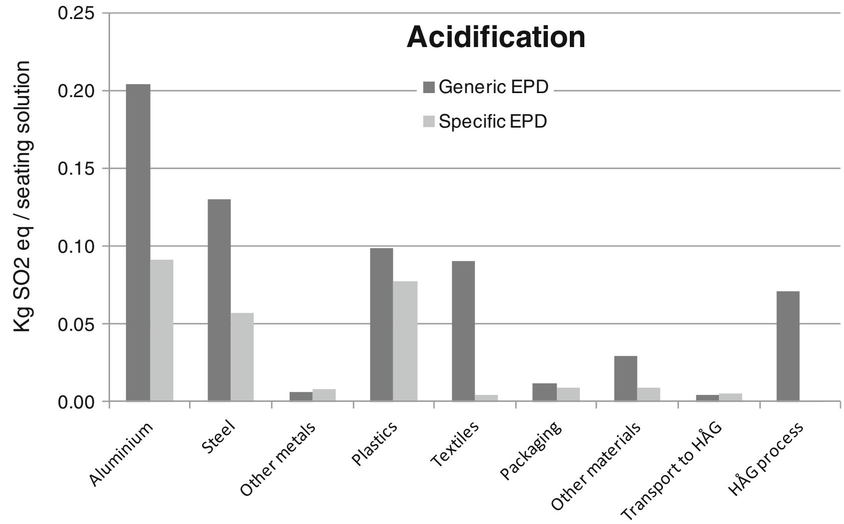

Fig. 5 Comparison of absolute values for acidification impact sorted according to materials, transport to HÅG and HÅG process for one seating solution

a little higher than the specific data. For PP, the generic data with specific recycled content lie between the generic and specific data. This would imply that the recycled content plays a smaller, but significant, part in the GWP for this material. Here, the different processing routes used for the specific and generic materials have a larger impact on the results.

The degree of variation in the results relating to the EPDs, based on specific and generic data, is dependent on how far the processes or materials diverge from the average. A lack of data variety in the generic database also has an effect. Textiles and mounting and metal work are examples of materials or processes which have large differences between specific and generic data. A substitute textile was used in the generic EPD since the database could not provide data for the material in question, and “metal product manufacturing, average metal working” was chosen for mounting and metal work at HÅG. It must be emphasised that there are significant uncertainties in these data. These might be considered to be unimportant in the case of this particular office chair as textiles and mounting and metalwork processes do not contribute a large percentage of the total result, but the authors maintain that they are worthy of attention when considering data requirements.

The HÅG process is the only process that was modelled with a different electricity mix in the two analyses. In the specific EPD, the chair producer was given credit for buying certified renewable energy, whereas in the generic processes, the average Nordel energy mix (Nordic) was applied. This would explain the variation in the results for the “HÅG process” when comparing CED (see Fig. 3) with global warming potential (see Fig. 2). The CED graphs indicate the deviation due to use of generic data for metalworking processes at HÅG (approximately 80 %), while the additional deviation is due to differences in the electricity mix used. This calls not only for the collection of electricity mix data but also a need to establish common guidelines as to the way in which electricity mixes should be calculated in

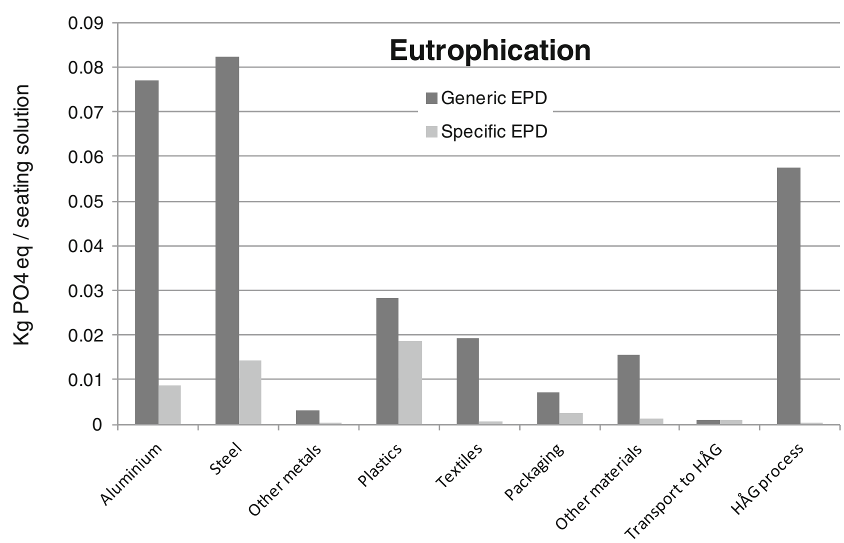

Fig. 6 Comparison of absolute values for eutrophication impact sorted according to materials, transport to HÅG and HÅG process for one seating solution

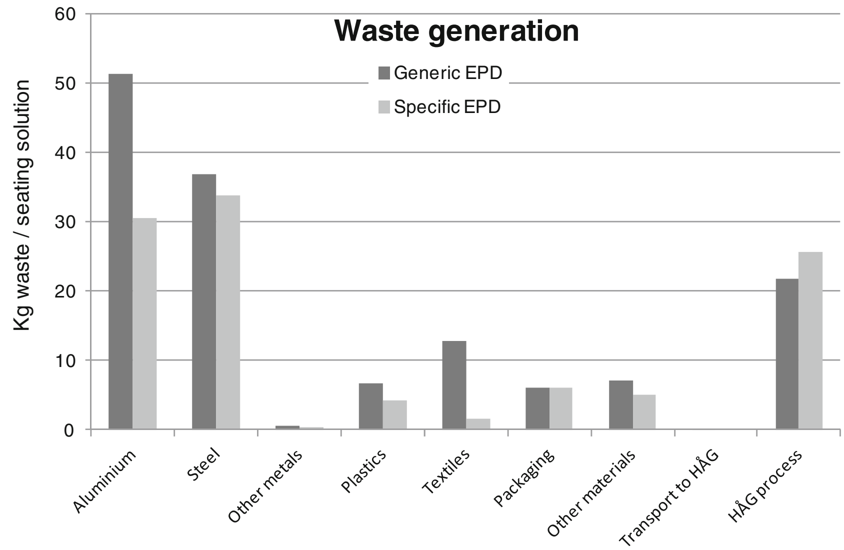

Fig. 7 Comparison of absolute values for waste generation sorted according to materials, transport to HÅG and HÅG process for one seating solution

LCAs. This is beyond the scope of this article, but has been explored by other authors (for example Raadal et al. 2009, 2012).

With regard to waste generation, the data collected for the specific EPD (from HÅG's suppliers) have not been characterised or analysed; it is merely given as waste per kilogram produced product. This could explain why the results do not follow the trend of the other impacts and inventory shown and referred to here.

4.2 The role of specific data in improvements

As described in Zackrisson et al. (2008), EPDs are seen as an important tool to stimulate demand for greener products through easily accessible, understandable and credible information. It is clear that regardless of the differences in EPD results, company-specific data are important for motivating company-specific environmental improvements. This would apply both to the companies supplying the products and their suppliers (Modahl and Nereng 2007). If data for EPDs are widely generic, the differences between two companies' products will become smaller and smaller, and the environmental profiles associated with products from different suppliers will not show significant differences. This will detract from one of the main motives companies have for providing EPDs. Norwegian companies certainly recognise this issue (ibid.). If they cannot use EPDs to show why their specific product has a given environmental edge, then price will be the sole basis for competition, and as long as they are not required by the authorities, environmental improvements can become irrelevant.

The process of gathering specific data from suppliers may be time-consuming, but also contributes to raising their environmental awareness (Nereng and Modahl 2007). Huber

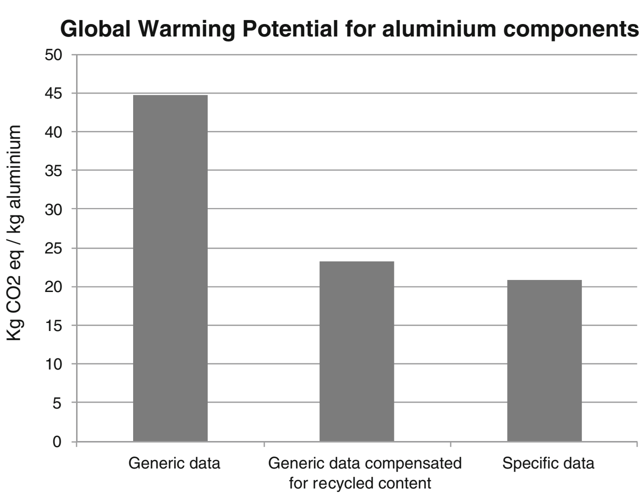

Fig. 8 Comparison of absolute values for GWP impact for 1 kg aluminium sorted according to materials, transport to HÅG and HÅG process for one seating solution

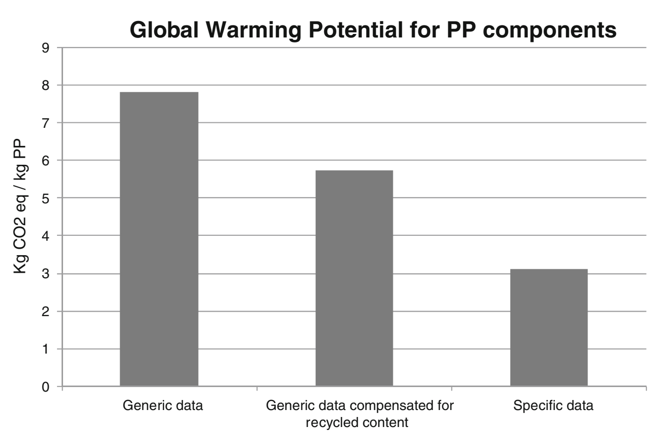

Fig. 9 Comparison of absolute values for GWP impact for 1 kg PP sorted according to materials, transport to HÅG and HÅG process for one seating solution

(2008) notes that key manufacturers can, if they wish, have a decisive influence on suppliers along the chain of production as they are both suppliers and influential buyers of goods and services. The potential influence of a strong buyer/supplier relationship is also shown in Brekke (2009). EPDs can be an important tool in facilitating the push/pull power for sustainable development, which companies like HÅG can have. However, the use of purely generic data removes many of the potential benefits of differentiating between suppliers on the basis of environmental performance.

It could be argued that certain key parameters, such as recycled content, chemical consumption and energy use, subsequently combined with generic data, should form the basis for supplier inquiries. This would encourage improvement among suppliers and create an EPD which is “sufficiently specific” to generate competition between final products. This would depend, however, on the existence of a process for identifying these key parameters with respect to environmental impacts, and on agreement at EPD programme level on what could be defined as being “sufficiently specific”.

4.3 The argument for practicality

Problems in LCA and the life cycle inventory phase are discussed by several authors (Owens 1997; Finveden 2000; Reap et al. 2008a, b). One significant problem is the degree to which the specific process or material diverges from the average, although this is described as being less important than allocation and cutoff (Reap et al. 2008a). In the main, however, these references address differences in data arising from conscious decisions and the selection of different methodological approaches. Owens (1997) addresses the issues of data quality and availability which can arise if data are collected from a variety of sources, rather than from “the most accurate source—production sites”. As mentioned in Section 1, the collection of data from suppliers to the EPD commissioner is expensive and time-consuming. There is a limit for what is practically achievable, and costs will most probably set the limit. This article investigates the consequences of primarily applying generic data. This may impede competitiveness, environmental awareness and environmentally sound product development, as described above. It also looks at the question of increased risk of human error when collecting specific data (Reap et al. 2008b; Björklund 2002). When a significant number of suppliers are asked for information on consumables, energy use, waste generation and emissions, a lot of responsibility is placed in the hands of the suppliers' representatives who submit the data. Although they can often be trained in environmental questions, this is not always the case, and it is quite probable that mistakes may be made in the reporting of data (Björklund 2002; Nereng and Modahl 2007). This is the case in the situation described by Reap et al. (2008b) where data have been collected from outside the LCA practioner’s organisation. This adds to the complexity of the work; the LCA practitioner has not only to spend time sending out questionnaires and making sure they are returned, but a substantial period of time must be spent on follow-up questions in order to detect errors (Nereng and Modahl 2007). Most errors should be fairly easily detected, for example, using comparisons with generic data to check whether or not they are in a probable range. No analysis has been performed regarding the extent of these possible errors when compared with the uncertainty of generic data. This could be a topic for further research.

4.4 The implications of the findings

In the case presented here, the company cannot surprisingly (see Section 4.1) reap the benefits of its environmental focus in environmental documentation and the marketing of its products. The generic data case is here described as flawed. This is a case study, but the findings are applicable to both good and not as good performers. The results are also applicable to EPDs for a wide range of products, and there can be few cases where the findings and conclusions from this paper would not be relevant.

The authors recommend that the EPD programmes should establish precise, unambiguous definitions and vocabulary; that these should apply to specific, as against generic, data when combined with foreground and background systems; and that the existing documents (ISO 2006a, The Norwegian EPD Foundation 2009) should be improved. Perhaps the institutions strictly advocating specific data could become more lenient with regard to certain data (for example production process data), but other important data should be company specific for all practitioners (for example data regarding the amounts of base materials and how much energy is used). It is likely that these requirements will vary according to the product (Product Category Rule level), but these issues are of such importance that they need to be raised at a (higher) programme level. The recently published EN 15804 (2012), which states that specific data should be used for the product manufacture and that generic data could be used for upstream and downstream processes, does not distinguish between *amounts* of base materials and energy and *emission profiles* for these when it comes to data quality for upstream processes. Precise, unambiguous definitions and vocabulary would avoid misunderstandings or false agreements when discussing data quality, as would

comparisons of products based on very different assumptions. Ideally, a consensus on definitions should be reached across EPD programmes and also in the wider LCA research community. This article could be a valuable contribution to such a process.

The preliminary results from this study would imply that the recycled content of materials and electricity mixes are important parameters and that as such they should be specific, while transport seems to have less significance. Transport could be of interest, however, if striving for continuous or long-term improvement. There was no focus on efficient, specific transport for the specific EPD case presented. It is likely that if HÅG pursued a policy of choosing transporters who only used the cleanest technology and full containers, the differences in transport impacts between a generic and specific case could be significant for the overall transport emissions (Ecoinvent database 2010). The differences would however be small for the overall results (see Figs. 2, 3, 4, 5, 6, 7 and 8). The distinctiveness of the material and material processing steps as well as proximity to the foreground system affect the accuracy of the generic data. However, in the final analyses, these are not necessarily the most important contributors to the environmental impacts. It should be repeated that for processes far upstream (in the background system), all Norwegian institutions performing EPDs use database data today and aspire to ensure that they are as representative as possible, but it should be remembered that they are, nevertheless, database data. Further research is required before clear recommendations can be made as to data quality specifications. This is briefly described in the chapter on recommendations in Section 6.

5 Conclusions

The results show that the differences from using the two datasets are substantial, and they become greater the more distinctive the process or material is. The authors have shown that the choice of electricity mix and recycled content have a considerable impact on the results, although the significance of the latter varies according to the specific type of material.

Use of company-specific data is not only important for creating accurate realistic LCAs and EPDs but also for increasing the knowledge which enables producers and material suppliers to implement environmental improvements in the value chain.

EPD programmes and PCR documents should establish precise, unambiguous definitions and vocabulary with regard to specific, as against generic, data when combined with both foreground and background systems, thus avoiding misunderstandings or false agreement when discussing data quality and avoiding product comparisons based on very different assumptions.

6 Recommendations for further research

Further research could include the performance of sensitivity analyses, altering, one at a time, the parameters, which have been shown here to be important. These could include, for example, the recycled content of various materials and electricity mixes. This would contribute to an increase in knowledge regarding the significance of these factors. Calculations and analyses, including sensitivity analyses, should also be performed where component production processes are distinguished from raw material extraction and base material production. In addition, there should be a study of other types of products, user phase and waste scenarios, before general recommendations are made.

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